XV. *Temperature Experiments in* 1893 *on several species of* Vanessa *and other Lepidoptera.* By Frederic Merrifield, F.E.S.

[Read March 14th, 1894.]

Plate IX.

In my last paper (Trans. Ent. Soc. Lond. 1893, p. 57) I described some experiments on pupæ of *P. napi*, offspring of the spring emergence, and mentioned that I had some pupæ offspring of the summer emergence. The parents consisted of two males and two females, taken at Hailsham, and kindly sent to me by Mr. Vine on the 30th July, and two females taken at Petworth on the 5th August, and kindly given to me by Mr. Fletcher. From these I had several hundred eggs, which were laid much more freely on *cardamines* than on cabbage, though the larvæ seemed to feed as willingly on the latter as on the former.

Early in September nearly all pupated. Ten were placed at 90° for ten days, a period amply sufficient to have caused their emergence had they belonged to the earlier brood, but it produced no effect either on the date of their emergence, when afterwards placed out of doors, or on their markings or colouring. The rest were kept out of doors. Some were forced about the middle of February, and some more early in March, emerging in from eight to seventeen days. The difference in appearance between these and the rest, which emerged out of doors between the 20th April and 9th May (except one which emerged 6th June), is the same in kind (though somewhat less in degree) as the difference between those of the summer emergence, which were forced all through, and those of that emergence which were cooled for the greater portion of their pupal period, as described Trans. Ent. Soc. Lond. 1893, p. 57.

Consequently I may apply to the winter pupating brood the general remark made there, as to the brood which pupates in the summer, viz., that a part but not all of the characteristic seasonal colouring of this species depends on the temperature to which the individual is

subjected, adding that the spring emergence appears to be less sensitive than the summer emergence is to temperature. Neither of the broods experimented on by me has proved so sensitive as those operated on by Prof. Weismann, and described by him ("Studies in Heredity").

Pararge egeria. This insect has two well-known climatic forms, the light spots in the South European form having the bright ochreous colouring of *P. megæra*, instead of the straw colour of the English var. (*egerioides*). But the experiments tried afford little or no reason for supposing that these differences in appearance are the direct result of temperature.

I obtained, between the 25th May and the middle of June, more than one hundred pupæ, which were subjected to various temperatures from between 80° and 90° down to 33° (for many weeks), with various transfers from the lower to the higher temperatures.

The chief difference, in general appearance, is between Classes I. and II. (forced) on the one hand, and Classes IV.–XIV. (those at 56° and under). The former have the light spots smaller and less clearly defined, and the dark ground colour considerably lighter, and in many cases freckled with small dark brown spots. Class III. (open air, at about 66°) are not quite so dark as Class IV., but much nearer to them than to the forced.

Though the light spots in those forced are smaller than in the others, they are somewhat more numerous. Class VIII. (iced and then forced) have the ground colour dark, but the light spots as numerous as in those which were forced, and as large as are the spots in those at the lower temperatures. One of these indeed, which I exhibit, has an inner row of light spots or traces of them on the secondary wings in nearly all the interspaces, and on the underside a perfect submarginal chain of six light spots, pupilled with dark brown, on a light ground colour.

A few examples I reared from eggs laid in August showed the same effects generally as those from the eggs laid in April and May, so that there does not appear to be any marked constitutional difference in this respect between the spring and summer emergences of this species; my experiments would, however, lead me to expect those which emerge in spring to be in general

more vivid in their markings and colouring than those which emerge later, after a spell of hot weather.

Cidaria silaceata. This is known to be very variable in its markings, and I was tempted to experiment on it by the remark of M. Guenée that the spring and summer broods appear to vary as in the *Selenias,* and by other observations (Ent. Record, ii., 297), to the effect that the summer brood is smaller, and the band across the forewings less broken.

Mr. Nicholson kindly gave me some eggs early in April, from which I had pupæ, which were subjected to about the same variety of temperatures as were the pupæ of *P. egeria,* above mentioned.

The main difference is between those at or over 80° and the rest; the latter being more strongly marked than the former, the transverse band perhaps showing a slightly greater tendency to be broken, and their light markings being of a rather more ochreous tint; as a consequence, those at 80° or over have a duller and more uniform appearance than the others.

But the most distinctive feature is in the size. Those at or over 80° are, as a class, smaller than the others. This species, therefore, must be added to those in which temperature, during the pupal period, affects the size of the imago. The difference in colouring and marking is hardly as great as I should have expected, and seems scarcely so great as that sometimes met with between the spring and summer natural emergences, though it is in the same direction. I intended to experiment on the winter pupating brood, but a brood which I had from the second emergence came out as a third emergence, and were nearly all spoiled before I discovered that they had emerged.

Araschnia levana. Desiring to experiment with pupæ of the summer emergence (var. *prorsa*) for their whole pupal period, I obtained, through Mr. Edwards, from North Germany, a large number of pupæ from which I had, towards the end of April, thirteen good pairs, which I placed over growing nettle, in headless casks, and fed on orange, etc. All circumstances, including abundant sunshine, appeared most favourable; but I only obtained thirty-two eggs, laid (I believe by a single parent) mostly in strings of from two to eight, projecting from the undersides of the leaves. Only eleven

hatched, beginning 15th May, and all of them pupated. Three were forced at 80°, producing in from six to seven days the characteristic black *prorsa* form; four others were, at from one to eight hours' old, placed in the refrigerator on the 18th June, and remained there, at about 48°, till 30th or 31st August (seventy-three or seventy-four days), when, observing signs of emergence, I placed them in the room at about 65° to 70°, and there three of the four emerged in a day or two, the fourth not until thirty-two days more, *i.e.*, on the 2nd October.

The remaining four were placed at 33° till 29th September (eighty-four days), then moved to the refrigerator at about 48°, whence, after twenty days more, they were moved to the room, about 59°, three of them emerging respectively in ten, eighteen, and twenty days more (total 114–124 days). The first of them was a cripple, and the fourth died. This left six of the eight subjected to a low temperature. These six all emerged in perfect condition, and were unmistakably of the true *levana* type; two of those cooled, without having been iced, showing slight traces of the intermediate *porima* form, but the other four being of the pure *levana* type, and nearly as different in colouring from the three that were forced as one of the common fritillaries—say *A. selene*—is from a "white admiral" (*L. sibilla*). I exhibit examples of the two forms.

I now proceed to describe some experiments on four species of the genus *Vanessa*. In reference to these I have had the great advantage of submitting the specimens experimented on in the manner described in this paper, to the careful examination of Dr. Dixey, whose paper on the phylogenetic significance of the wing-markings in certain genera of the *Nymphalidæ* will be found in Trans. Ent. Soc. Lond. 1890, p. 89, and he has favoured me with valuable observations upon them, which I am permitted to append; they are distinguished by being placed within brackets. The "series" and "spots" referred to in these observations are described in Dr. Dixey's paper, and may be indicated generally as follows, *V. urticæ* and *V. polychloros* being convenient examples for the purpose:—Four dark patches on the costa, continued in series more or less perfectly across the wings, distinguished by the Roman numerals I., II., III., IV., the latter including the dark submarginal band.

Four lighter areas, A, B, C, D, alternating with the dark ones, A being the innermost, and coming before I.; these also continued in series more or less across the wings.

Vanessa polychloros. There were sent me on the 6th May, a brood of between 130 and 140 larvæ found on sallow in the New Forest; they were about three-eighths of an inch in length. I found they would eat cherry and birch, but seemed to prefer willow, on which accordingly I placed them, at first in two, and afterwards in four, large sleeves. On the 27th May, one had begun to spin, and all were brought indoors and fed on cut willow. There were 138; by the 31st 127 had spun up, and the rest followed in a few days. Their pupæ were subjected to temperatures ranging from 100° to 32°, being in many cases transferred, after a time of varying length, from the lower to the higher temperature, or *vice versa*. I proceed to give their treatment in detail:—

Class I., forced at from 90° to 100° (Plate IX., fig. 1). Most of these died, but a few at 90°, or a few degrees lower, did well; forced as pupating larvæ or pupæ under twelve hours, they emerged in seven days. A second lot of ten (Class II.) were put in a shady place out of doors, where the temperature averaged about 62°, and all emerged in from twenty to twenty-two days. A third lot (Class III.) were placed in a cellar at a temperature averaging about 56°, where all emerged on the fortieth day. A fourth lot (Class IV.) were placed in the refrigerator at about 48°, and, after periods ranging from fourteen to forty-six days, transferred to (*a*) the forcing box at 80°–90°, emerging in from three to five days more; (*b*) the cellar at 58°, emerging in from twelve to twenty-five days more; or (*c*) the room, at 68°–75°, where they emerged in from four to five days more. A fifth lot (Class V.) were iced for periods ranging from fourteen to forty-two days, and then (*a*) placed at 80°–90°, emerging in five to seven days more; (*b*) in the cellar at about 59°, emerging in twenty-seven to thirty days more; or (*c*) the refrigerator at about 49°, for from six to thirty-two days, and then, either the cellar at 58°, emerging in from twenty-two to twenty-three days more, or the room at about 68°–75°, emerging in two to twenty-eight days more. With the exception of a few that were injured by accidents, of those that were killed by excessive heat, as mentioned before, and of four or five among those longest iced, all emerged, and except among some of those iced, there were no cripples.

The effect on colouring was as follows :—

Class I. (forced at about 90°, or upwards), emerging in seven days). The ground colour of a lighter and yellower hue of brown than is normal, with many yellowish clouds and broad streaks, especially in the interspaces of the nervures on the outer half of the forewings. [Black spots generally are more sharply defined than in normal specimens. There are no blue submarginal crescents in the forewings, but many bluish scales on the extreme margin. The spots in "Series D" are particularly well-defined near the costa, and are not pupilled.]

Class II. (shade, out of doors, at 51°–69°, averaging about 62°, emerging in twenty to twenty-two days). Ground colour of a redder brown, and with few yellowish clouds ; the yellow submarginal outer line is especially reduced, and the dark band inside it widened and darkened.

Class III. (cellar at 54°, rising to 58°, averaging 56°, emerging in forty days). Effects intensified ; the yellow submarginal line has almost disappeared, and there is a scattering of dark spots on the ground colour, in some cases forming a streak in front of the inner edge of the forewings. [There are indications of blue submarginal crescents in the forewings, but less blue in the fringe or extreme margin than in I. The spots in "Series D" sometimes bear minute black pupils.]

Class IV.*a* (refrigerator, about 49°, fourteen to forty-six days ; then forced at 80°–90°, emerging in five days). Effect rather a mixture of those in Classes I. and III. ; the scattering of dark spots exists, but the yellowish clouds and yellow submarginal streaks are partially restored ; in those exposed to the low temperature for forty-two days, there were several that died or were crippled, and the dark markings in some others are varied with a paler hue, giving rather a "greasy" appearance to these dark parts. [The spots of "Series D" often with minute black pupils ; "Series C" is indicated in the hindwings by a row of black points; a new dark spot tends to be formed between "II.8" and "III.8."]

Class IV.*b* (refrigerator at about 49°, fourteen to forty-six days; then cellar at 56°–60°, emerging in twenty-five to twelve days, or room 65°–75°, in five to four days). Much like Class III., except that the ground colour is duller, and the submarginal blue tends to be supplanted by black ; in those longest exposed to cold, the dark parts tend to spread. [Tendency to formation of new dark spots continues.]

Class V.*a* (iced at 33°, fourteen to thirty-eight days, then forced at 80°–90°, emerging in seven to five days). These, unless iced

twenty-nine days or more, are very like IV.*a* ; iced for that or a longer period, they are darker ; in all cases they show a return of the yellowish markings.

Class V.*b* (iced at 33°, fourteen to forty-two days, then at various temperatures, such as cellar at 59°, emerging in twenty-seven to thirty days ; or refrigerator at about 49°, six to thirty-two days, and then in cellar or room, emerging in twenty-one to two days more). These are classed together, because the effects seem to depend on the duration of the icing. No great effect is produced under twenty-nine days' icing ; the extreme darkness, often without crippling, is produced by icing thirty-six days, followed by the refrigerator at 49°, for six to nine days (Plate IX., fig. 3); but some taken straight from the ice to the cellar are nearly as dark. Of those iced from thirty-eight to forty-two days nearly all died, or were more or less crippled : one of the latter has nearly all the four spots on the forewings obliterated ; and it may be observed that the icing for thirty-six days or more, followed by the refrigerator, which produces the extreme dark effect, has a tendency to cause the normal spot near the inner edge, which is nearest the base of the forewing, to disappear.

As regards the general appearance of those which show the extreme effect of the low temperature, it may be said that they much resemble *V. xanthomelas*. [Tendency to formation of new dark spots continues. An additional dark spot may also appear in cell (forewing) below "I" and "II." The border may become uniformly dark.]

A second company of *V. polychloros*, just changing their last skin, reached me on the 2nd June, also on sallow. Sleeved on cherry they did very well. Some were forced, emerging in six and a half to seven days. Others, placed out of doors at a temperature ranging from 67° to 59°, averaging about 64°, emerged in sixteen to seventeen days. This was a rather lighter coloured company of butterflies. There is the same kind of difference in appearance between the forced and the others, as there is between Classes I. and II. of the first company, but it is less in quantity.

V. polychloros, general conclusions. The colouring is considerably affected by temperature in the pupal stage, low temperatures producing a deepening of the ground colour and an extension of the dark markings; and high temperatures producing a lightening of the ground colour and an extension of the yellowish markings. The blue and bluish markings are strongest in those at moderately

low temperatures, Classes III. and IV., in many of which they form some rather bright crescents on the forewings; but at the extremely low temperatures they tend to be supplanted, in some cases entirely so, by black.

[Forcing invariably tends to produce yellow, whether pupa previously warmed or cooled. Refrigeration produces increased breadth of dark brown, whether followed or not by forcing.] I may add that among the specimens I exhibit, one belonging to Class IV.*a* (refrigerator thirty-eight days, then cellar four days, and forced three days) (Plate IX., fig. 2), to which my attention has been directed by Dr. Dixey's observations, is particularly interesting, showing "Series D" as a nearly complete chain of faint yellowish spots, or rather clouds, on both forewings and hindwings, the anterior three or four on the forewings, and all those on the hindwings having each a small black point in the centre. It seems as if it required cold, succeeded by heat, to cause this chain of *yellowish spots centred with black* to be brought out.

Nothing has been said about the colouring of the under sides. This varies moderately in darkness or lightness, but I have not been able to associate this variation definitely with temperature.

Vanessa atalanta. In looking carefully, and aided by a strong light, at the *V. atalanta* upon which experiments were made in 1892, as recorded, Trans. Ent. Soc. Lond. 1893, pp. 58–62, I noticed a feature which had escaped me before, viz., that eight out of the ten which were subjected to the high temperature of 80°–90° had a few dull orange scales on the upper side of the forewings, between the large white costal blotch and the row of smaller white spots nearer the hind margin.

I determined to develop this tendency by exposing some pupæ to a greater heat. The effect was a great development of this orange colour, both in intensity, it becoming distinctly scarlet, and in quantity, so as to form a scarlet cloudy patch sufficient to attract attention on casual observation. I exhibit several examples. This patch is between the large white costal patch and the third of the row of white spots beyond, and tends to form a scattered ring around this third spot; other scales, from golden brown to scarlet, are developed along the outer part of the costa and near the base, and elsewhere on the forewing.

The following is a description of the treatment to which the pupæ were subjected, and of its results :—

A considerable number of pupæ were placed at a temperature of about 100°, at which nearly all died, after progressing so far as to show their imaginal colouring. I then lowered the temperature to about 90°–95°, with the result that the great majority of them show these markings, the scales being scarlet instead of dull orange, and in several cases being so increased in quantity as to form a scarlet clouding sufficient to attract attention when the insect is held at arm's length and more. These scarlet scales follow the nervure which separates the second from the third of the row of white spots above referred to; they are not on the nervure, but on each side of it, and in some cases extend to the nervure next below, and have a tendency to form a scattered ring round the third of the white spots. These scarlet scales are also to be found on the costa, extending in some cases from the beginning of the large white costal patch almost to the apex of the wing (an ochreous colouring in this region is to be observed in captured specimens). Associated with these markings is an increase of the brightness and warmth of the golden-brown colouring of the costa and nervures in the basal part of the wing ; in some crippled specimens this golden-brown is very vivid, and makes some approach in hue towards the scarlet band across the wing ; in some of these also a patch of the scarlet scales is to be found between the middle of the scarlet band and the large white costal spot.

In my paper on the experiments of 1892, I mentioned that on the underside of two out of ten specimens at from 80° to 90°, a new small scarlet spot appeared between the scarlet band across the forewings and the inner edge. In only six individuals out of those subjected to a high temperature in 1893 do I find scarlet in this region. I find it occurs in two places, both below the median nervure, viz., (*a*) just before it forks, (*b*) a little below the lower branch of the same nervure. One specimen (No. 4) shows both (*a*) and (*b*); three (Nos. 21, 39, and 49) show (*a*) only, and two of them but slightly; and two (Nos. 48 and 188) show (*b*) only.

The scarlet scales on the upper side are found in the great majority of those (about thirty) that were subjected to a temperature of 90°, or upwards, during their whole pupal period, and in three out of thirty-three that were subjected to 80°–100° during the earlier part of their pupal period ; they are not found in any of the forty or so that were subjected to lower temperatures. The

scarlet patches on the under side are only found in six out of forty-eight which were subjected to 99° or upwards, and five out of the six were so exposed for practically their whole pupal period.

In the opposite direction of low temperature, I tried further experiments with *V. atalanta*, the most marked results of which I exhibited at the meeting of the Entomological Society on the 8th November, 1893. They confirm, and in some cases carry further, the results obtained in the previous year. The low temperature causes much substitution of white, lavender, or metallic blue-green scales (one of these colours seeming readily in this insect to pass into another of them) for the black in normal specimens; the large white spot on the costa is greatly enlarged and spread, and the tendency of the third of the row of submarginal spots to ocellation which is above referred to, as caused by a high temperature, is shown in a different manner by the low temperature, which tends to form a whitish ring round, and very near to it (this third spot is on the underside ocellated in normal specimens).

The extreme low temperature forms are, on the whole, so decidedly smaller than the average, that I am inclined to think the low temperature is a cause of reduced size in this species, more especially as those at the high temperatures, even where this is so extreme as to kill some of them, are all of full size.

[*Forced.*—Resolution of inner margin of red band fairly marked.

Refrigerated.—Marginal blue much extended, especially about anal angle of hindwing and in centres of spots of "Series IV."; spots of "Series D" often ringed with pale blue, apart from ocellation; indications present of bluish centres to "Series III." in hindwings; greater general blackness.]

Mr. J. J. Walker has kindly given me a specimen from Gibraltar which resembles, in its main features, some of my earliest individuals. It was taken, recently emerged, on the 17th February, and I find that the mean temperature of January and February at Gibraltar may be as low as 48·7° and 50·9°. Dr. Chapman has kindly sent

me some *atalanta* of a very late brood reared last October and November at Hereford, which also present some of the characteristic appearances of my cooled specimens.

Vanessa (*Grapta*) *c-album.* Owing to the kindness of Mrs. Hutchinson, who sent me some eggs laid by hibernated butterflies in the spring, and of Mr. Nesbitt, of Llandogo, who sent me larvæ of the second brood at the end of July, I have been able to ascertain that while both broods are affected by temperature in the pupal stage, the first brood is much the more sensitive of the two. It is remarkable that there should be so great a difference in constitution between these two broods, as, under natural conditions, the pupæ of both broods are exposed to temperatures differing by a very few degrees, the one passing the pupal stage in England about June, and the other about August. It is entirely consistent, however, with Mr. W. H. Edwards' experiments and observations on the two closely-allied American species, *Grapta interrogationis* and *Grapta comma*, as described in the "Canadian Naturalist" for 1877 and 1878, and much light is thrown on the subject by Prof. Weismann's observations on Mr. Edwards' experiments, in the Professor's "Studies in Heredity," by Prof. Meldola, vol. i., p. 149. The individuals experimented on, eight of the first brood and eleven of the second brood, were not sufficiently numerous to justify me in describing the results in detail; but I hope to try experiments on a much larger scale during the present year.

Vanessa io. Mr. Morris, of Lewes, kindly gave me a company of about one hundred and twenty larvæ, all in their last skins, or nearly so, on the 15th June, which in the extraordinarily early season of 1893 was late for them. I was much occupied in other ways, and perhaps it was owing to insufficient attention that I did not obtain more than about sixty pupæ, and those were a little under the full size. They were subjected to various temperatures from about 100° downwards. Those at 100° all failed to emerge. Sixteen, which were at 90° for six days, and then at 80°, all emerged in one day more, making seven days. As the temperature was lowered, there appeared a gradual tendency to disintegration of the ocellus on the forewing, until in one

(Plate IX., fig. 4), iced at 33° for twenty-two days, then in the refrigerator for twenty days, and then in the cellar for eighteen days, it ceases to be an ocellus, being resolved into a chain of small white spots, which are bright, with only a very slight bluish shade about them, and affording a remarkable confirmation of Dr. Dixey's views of the origin of that ocellus, as exemplified in the plate attached to his paper in the Transactions for 1890. In these iced and cooled specimens the blue becomes more vivid, and a narrow dusky marginal band, slightly darker in hue than the chestnut brown ground colour, appears, with a submarginal incomplete row of small dusky spots, very distinct. On the hindwing there is little change, but a tendency to disintegration of the blue in the ocellus.

Dr. Chapman kindly sent me, on the 30th August, part of a second brood he had found rather more than half grown. From about forty larvæ I obtained thirty-eight fine and healthy pupæ, but nearly all were killed by the severe cold to which I subjected them, though only a little in excess of that to which No. 61 was exposed.

[I. *Forced*: a tendency shown to the development of dark spots at the apices of the interspaces ("Series II."); tendency towards fusion of bluish constituents of ocellus in hindwing. II. *Cooled*: tendency of "IV." (marginal chain) to separate from "D" (light apical spots); "IV." rendered more distinct in forewing. III. *Iced*: separation of "D" and "IV." as in II. "Claw-mark" tends to lose regular curve, and to become angulated. Bluish constituents of ocellus in hindwing tend to become separated into two parallel series—"III." and "IV.," *i.e.*, a marginal and submarginal.]

V. antiopa. About seventy pupæ, mostly rather fresh, were obtained for me from near Berlin by Mr. Edwards, on the 19th July, and were subjected to various temperatures from about 100°, emerging in from three to five days, and 80°, when they took a day or two more, downwards. The most severe temperature survived, without injury, was twenty-seven days in the refrigerator, at about 47°. All that were placed in ice (33°) for twenty days or upwards died, except one that was a cripple. The results are negative, as none show any marked differences in marking or colouring that can be assigned to temperature. The absence of positive

results is very probably owing to the circumstance that the pupæ were all of them several days old when they reached me.

The experiments now recorded confirm in general the conclusions drawn from such as have preceded them, and some of which may be briefly enumerated as follows:— (1) The effects of temperature are different when applied at different periods of the pupal stage. (2) A great range of temperature may cause but little difference in appearance, while a very few degrees near the top or bottom of the range the insect will bear may cause a great difference. (3) There may be a great constitutional difference in sensitiveness to temperature between two seasonal emergences of the same species. (4) This may be so even when both pass the pupal period at about the same temperature (this is in accordance with Mr. W. H. Edwards' observations above referred to). (5) While some kinds of effect seem to be what may be called the direct result of temperature, in others, and perhaps the most important, temperature appears to operate by causing the individual to "throw back" to some ancestral form; this last circumstance has been considered to explain the reason why a low temperature in some species causes darkening of the colours, and in other species produces the opposite effect. (6) In these cases of "reversion," the kind of effect produced appears to depend on the stimulus applied, low temperatures producing one class of effects and high temperatures a different class of effects.

The whole subject is one of much complication, and calls for further experiments in many directions. The direction which mine have taken, following in the lines initiated by Weismann and W. H. Edwards, especially if pursued with species belonging to regions where the seasonal or other occasional differences of temperature are extreme—North America, Siberia, Japan, or the vicinity of mountains—will help to trace, and separate from the rest, such of the causes of variation as depend, directly or indirectly, on temperature. Systematic experiments on a number of well-selected species belonging to countries where the seasonal difference is hygrometric rather than thermometric, would probably produce valuable results. The nature of the food-plant,

which undoubtedly influences size and vigour, and is generally considered also to influence markings and colour, offers another line in which experiments of a more systematic and comprehensive character than any yet tried would undoubtedly well repay the labour attendant upon them. There are other natural surroundings, most potent for many purposes, the effect of which might usefully be tested by experiment, such as light and electricity and magnetism. As to light, I tried, in 1891, some experiments on *B. cynthia* and *S. illustraria,* recorded in the Trans. Ent. Soc. for 1892, p. 42 ; but, so far, with negative results. And in 1891 I tried some experiments with strong magnetic currents on some Lepidoptera in all their stages; but these yielded no positive result.

Note.—As this paper and Dr. Dixey's, which succeeds it, contain observations on some of the same facts by two different and independent observers, there is necessarily some repetition, but in order to reduce this as much as possible, I have greatly condensed my own observations.

Explanation of Plate IX.

Fig. 1. *Vanessa polychloros*: pupa at 90°–95°, emerging in seven days.

Fig. 2. *V. polychloros*: pupa about 49°, for thirty-eight days, then about 58° for four days, then about 85°, emerging in three days more.

Fig. 3. *V. polychloros*: pupa at 33° for thirty-six days, then about 49° for nine days, then about 58°, emerging in thirteen days more.

Fig. 4. *V. io* : pupa at 33° for twenty-two days, then about 49° for twenty days, then about 60°, emerging in eighteen days more.